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FISH MEAL: ITS USE AS A STOCK AND POULTRY FOOD.

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INTRODUCTION.

The use of fish meal in this country at the present time for feeding purposes is so limited that it may be said that in commercial quantities it has scarcely begun to be marketed. The Connecticut Agricultural Experiment Station[1] in its report on feeding stuffs for the year 1914 gives the results of examination of one commercial brand sold by an eastern firm. Fish meal is used by another eastern firm as the protein basis of a poultry food. It has been prepared for some time on the Pacific coast, and there are several brands already on the market from that region. One of these products is made of a mixture of fish meal and meat meal. As commercial by-products fish and the waste residue from fish have always in this country been converted into so-called "scrap" or "pomace" for use as a fertilizer ingredient. An entire industry, the fish-scrap fertilizer industry along the Atlantic coast, has grown up, in which a single species of fish, the menhaden, is used as a source of raw material. In the early days of this industry the oil was the principal material sought; the "scrap" was considered waste and was not generally used as a fertilizer.

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[1] Conn. Agr. Exp. Sta. Rpt. 1914, pt. 4, p. 221.

Note.—The object of this publication is to set forth the value of fish meal as a food for domestic animals, in order to stimulate its more general use as a supplementary stock food and to encourage its manufacture for that purpose.

It is indeed surprising that in the matter of furthering economy the use as a stock food of fish meal prepared from undecomposed raw material has not been fostered in this country. This is particularly striking in view of the fact that attention was called to the possibilities of fish meal as a feeding stuff a number of years ago, both in this country and abroad. In 1877 Dr. W. O. Atwater[1] reviewed the manufacture and use of fish manures and at that time urged the use of the fish scrap from the menhaden as a source of protein for stock foods. Such use of this material would have made possible the utilization of its high feeding value and at the same time would not have impaired, but to a great extent would have enhanced, its fertilizing value. The fertilizing constituents would be more available after digestion, and manure from animals so fed would contain the plant food material derived from the fish in a more readily assimilable form.

The experimental work on the use of fish meal as food for stock dates back to the time when similar work was conducted in connection with the use of meat meal and tankage for this purpose. In fact, in this country even before the attention of feeders was called to these latter foodstuffs as supplementary stock foods, reports of experiments directed attention to the use of fish as food for domestic animals. Dr. Atwater[2] in his report records the year 1835 as the earliest in which there appears any account of the use of fish as food for domestic animals.

As early as 1864[3] fish "pomace" or "chum" (the residue left from herring or other small fish after removal of the greater part of the oil by pressing) was spoken of in high terms as furnishing a valuable feed for sheep, swine, and fowls, all of which ate it greedily. No doubt use was made of fish in this form, in isolated instances, by farmers living near the coasts who had access to this material in its fresh condition. The writer has been informed of its use in Maine in the early days of the sardine industry, when the residue from the packing of sardines after removal of part of the oil by pressing was fed to sheep with excellent results as to fattening and wool production.

Shortly after the time the earlier experimental work and feeding tests were made to ascertain the value of waste residues of animal origin and of fish meal for feeding purposes, it appears that preference was given to such material as meat meal and tankage, and that in after years fish meal was forgotten. It was also generally assumed that feeding domestic animals fish would result in imparting a characteristic taint to the food products from the animals. This impression was undoubtedly obtained as a result of allowing animals to eat too freely of fish wastes, particularly that which was in an advanced stage of spoilage. The present time—feeding stuffs of high protein content being so much in demand—would seem to be a fitting and proper one in which to call upon this reserve supply of protein so abundantly supplied by waste fish and by the waste of fish-canning industries.

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[1] See his special report on "Menhaden and other Fish and Their Products as Related to Agriculture" to Goode, "History of the American Menhaden," U. S. Fish Comm. Rept., 1877, pp. 194–267.

[2] Goode, Atwater, loc. cit., p. 258.

[3] William D. Dana, in a report of the Maine Board of Agriculture. See Agriculture of Maine, 1864, p. 43.

REVIEW OF LITERATURE.

The literature on the use of fish meal for feeding purposes was found to be more extensive than casual inspection had shown. The greater part of the experimental work on this subject has been conducted in Germany, as a result of which the use of this material for feeding purposes in that country is now on a firm basis. The more important articles are cited here in chronological order and fairly full abstracts are given of some, in order that the accumulation of evidence may allay any prejudice that may exist against the use of fish meal as a foodstuff for domestic animals.

In 1869 M. L. Wilder,[1] of Pembroke, Me., a member of the board of agriculture of that State, presented his experience in the use of fish "offal" as a feed for sheep. He believed "fish offal to be not only cheaper but much superior to any other kind of provender he had ever used" for this purpose. The "offal" referred to was made from herring, which were salted the same as for smoking, cooked, and the oil pressed out. It is stated that the sheep ate of this more eagerly than of grain. Experiments similar to the above were made by other persons in later years.[2]

In 1875 Farrington[3] conducted feeding experiments with sheep at the Maine Agricultural College, comparing the value of equal quantities of corn and of fish "pomace" made from herring. Two flocks of 5 lambs each were fed about 2 ounces per head per day, the lambs in each group being allowed all the hay they would eat. During the 16 weeks of the experiment the corn-fed flock gained 48 pounds, or 15.13 per cent, and the lot fed on fish 47½ pounds, or 15.01 per cent.

Henry, in *Feeds and Feeding*, reports statements from several authors to the effect that it has been determined that no bad influence on the milk is found when dried fish are fed in reasonable quantities to dairy cows, and that it has been found that 100 parts of linseed cake can be replaced in the ration for cows by 80 parts of herring cake. In one test milk and butter of normal quality were produced when 2.3 pounds of fat-free fish meal per day were fed with a variety of other feed. The statement is made by this authority that the better grades of fish meal should be used for feeding.

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[1] Agriculture of Maine, 1869, p. 60.

[2] Agriculture of Maine, 1874–75, p. 1.

[3] Cited by Atwater in Goode, U. S. Fish Comm. Rpt., 1877, p. 260.

In 1908 Lindsey[1] reported that in Europe a great variety of meat and fish meals had been offered for sale as stock foods as early as 1872. A review of a number of experiments with horses, cattle, sheep, and swine established the fact that these materials, when properly prepared, are excellent foods for stock and poultry, and that they are highly digestible.

Notwithstanding the favorable reports recorded on the use of fish meal it was ignored at this time, preference being given to dried blood and tankage. This was in part due, no doubt, to the fact that the industries producing these were more highly organized and their selling arrangements proportionately greater.

Turrentine[2] calls attention to the use of fish scraps as a feeding stuff for poultry and stock and gives extended quotations from the report by Goode, cited above. From his review of the early feeding of fish in this country he concludes that "the universally affirmative results of all the recorded experiments with fish scrap as a cattle feed leave little room for doubt as to its efficiency." He remarks further: "It is indeed surprising that its use as a feed has not been more generally introduced. * * * It would be fitting, indeed, that even a small part of the millions of pounds of combined nitrogen carried seaward annually by the rivers should be returned and after a short cycle again should be rendered suitable for man's consumption."

According to Kellner[3] milch cows may be fed as high as 2 pounds per day with no objectionable taste or flavor resulting in the milk or butter. Feeding to sheep or horses is best accomplished by mixing it with other feeds. It is recommended that one-half pound per day be given.

F. Lehmann[4] ranks fish meal next to meat meal in its content of nourishing material. Laboratory experiments showed that 98.6 per cent of the protein was digested with pepsin and pancreatic extract. It is also pointed out that fish meal, on account of the length of time required to render the nitrogen and phosphates available for plant assimilation, is not a very good fertilizer; but that it is a very good feeding stuff and when so used its fertilizing value is enhanced, since the fertilizing ingredients reappear in the manure in forms more easily used by plants.

Kühn-Cornieten[5] conducted a practical test with six cows, comparing the yield and quality of milk and butter when the cows were fed a ration containing no fish meal with the results obtained when fish meal was substituted for dried malt husks and sunflower meal in the basal ration. From 1⅓ to 2⅓ pounds (German) fish meal were fed per head per day in the different trials. The milk produced during the experiment was analyzed. The yield of milk was fairly well maintained during the time fish meal was given, while the percentage of fat in the milk was increased. The butter did not have a fishy odor or taste and was declared to be about the same in quality as that produced on oil cakes. Since the quantity of milk was about the same, the percentage of fat higher, and the feed cheaper, it was concluded that fish meal was a valuable feeding stuff.

Fink[6] fattened steers with a ration including fish meal at the rate of 3 pounds per head per day. A gain of 303 pounds in 90 days was made. Nothing is stated in regard to the flavor of the meat.

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[1] Mass. Sta. Rpt., 1908, pt. 2, p. 149.

[2] "The fish-scrap fertilizer industry of the Atlantic coast"; Bul. No. 2, U. S. Department of Agriculture.

[3] Die Ernährung d-landw. Nutzthiere, pp. 369–371.

[4] Landw. Wochenbl. f. Schleswig. Holstein, 1892, No. 23; pp. 200–201.

[5] Molkerei Zeitung, 1894, *8* (44), p. 675.

[6] Deut. Landw. Presse, 1896, *23* (17) 1, p. 145.

Hals and Kavli[1] report analyses of fish meal made from slightly salted herring and from the waste of heavily salted herring. The composition of the former was: Water, 11.11 per cent; protein, 61.11 per cent; fat, 14.06 per cent; and ash, 11.79 per cent. Of the latter, the composition was: Water, 10.81 per cent; protein, 42.29 per cent; fat, 13.17 per cent; and ash, 23.06 per cent. Digestion experiments showed that 12.7 pounds of digestible fat and 56.3 pounds of digestible protein were obtained from 100 pounds of the meal made from whole herring, while the meal made from the waste of salted herring gave 11.9 and 42.6 pounds, respectively.

In 1903 V. Schenke,[2] as a part of an extensive investigation of commercial feeding stuffs conducted by the German experiment stations, made an exhaustive examination of the subject of fish meal or fish guano, looking toward its use as a stock food. In this report it is stated that up to the middle of the last century fish meal or fish guano was used only for fertilizer purposes, and that it was not until about 1860 that any work of a scientific nature was done with the idea of using such meal as a foodstuff for animals. Attention is called to the fact that the protein consists mainly of meat fibrin, albumen, and gelatinous substances, the latter in larger proportion than in the flesh of fresh fish because the fish meal is prepared without removing the fish bones. It is also stated that the fat which remains after the pressing is easily digestible. The ash consists largely of sodium, potassium, and calcium phosphates, and sodium, potassium, and magnesium chlorids. Experiments conducted and literature cited in regard to the digestibility of fish meal showed that the coefficients of digestibility of the chief constituents are high.

According to V. Schenke the first feeding tests with fish meal were made in 1873 and 1874 by Weiske[3] and were reported in 1875 and 1876 by Kellner, Schrodt, and Wimmer;[4] the test animals were sheep. The investigators concluded that the protein of fish meal was digested by herbivorous animals as well as, or better than, the protein from vegetable sources. From 77 to 83 per cent of the protein was found to have been digested. Kellner in a later experiment,[5] found that sheep digested as much as 90 per cent of the protein, 76.4 per cent of the fat, and 15 per cent of the ash.

Reports of the work of a number of other investigators, extending from this year (1877) to 1902, are cited by V. Schenke, in which studies of the feeding of fish meal to dairy cows, oxen, hogs, sheep, and poultry are recorded. The results were universally favorable in all particulars as to economy in producing gains in weight, and as to lack of taint or odor of fish in the marketable products from these animals.

In conclusion this author states that fish meal is a valuable supplementary food for animals, when it is fed with other foods low in protein; that its most important feature is the high digestibility of the protein and fat and that, further, it imparted no objectionable flavor to milk and butter when used supplementally in rations for dairy cows.

In a feeding experiment on young pigs, comparing the growth obtained by feeding both milk and fish meal with the growth obtained by feeding milk only, Klein[6] found that smaller quantities of milk with the addition of fish meal gave as good a gain per head as was obtained by feeding larger quantities of milk alone.

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[1] Norsk. Landmandsblad, 1903, *22* (3) 38-41.

[2] Landw. Vers. Stat., 1903, *58*, 55-64. For full report of this investigation see Die Futtermittel des Handels. P. Paray, Berlin.

[3] Wochenbl. d. landw. Ver. i- Grossherzogtum Baden, 1874, p. 318.

[4] Journ. f. Landw., 1876, p. 265.

[5] Landw. Vers. Stat., 1877, *20*, p. 423.

[6] Deut. Landw. Presse, 1907, *34* (67), 542.

The comparative value of meat meal and fish meal as supplementary foods for swine was studied by A. Kleeman,[1] who conducted his experiments on 3 groups of 8 hogs each, using two grades of fish meal (one containing 2.10 per cent of fat and 48.90 per cent of protein; the other 4.80 per cent of fat and 51.50 per cent of protein) and a higher-grade meat meal, containing 80 per cent of protein. The ration, in addition to the high protein-bearing foods used, was composed of corn, steamed potatoes, potato chips, and potato flakes. Starch was used in addition to balance the ration composed of the fish meal low in fat. The deficiency of meat meal in phosphate of lime was made up by adding precipitated lime phosphate to this ration.

The pigs fed on meat meal were off their feed during the latter part of the experiment, while the lots fed the fish meal appeared to have sharpened appetites and ate the ration well throughout.

There was no difference in the Reichert-Meissl numbers of the fat of the hogs fed on meat meal and those fed on fish meal, but the iodin number of the fat was found to be slightly higher in the case of the hogs fed on fish meal. The quality of the meat and fat as regards taste, odor, and flavor was not affected by feeding fish meal. The author states that meat meal and fish meal are good fattening feeds for swine, and concludes, from his experiment, that, as food for hogs, meat meal and fish meal gave practically similar increases in weight, but that meat meal on account of the higher percentage of protein was from 60 to 80 per cent cheaper than fish meal.

This conclusion is based on the fact that in this experiment the fish meal cost a little more than meat meal.

Honcamp, Gschwender, and Engberding[2] report the results of experiments on sheep which were fed herring meal and whale-flesh meal, as supplementary feeds to clover hay. The herring meal used by them contained 58.30 per cent of crude protein, 56.28 per cent of "pure" protein, 3.98 per cent of nitrogen free extract, 13.57 per cent fat, and 23.65 per cent of ash. Digestion experiments conducted on sheep with this meal showed a utilization of 93.7 per cent of the organic substances, 87.7 per cent of the crude protein, 49.2 per cent of the nitrogen free extract, and 97.4 per cent of the fat.

It was noted in these tests that the animals digested the organic material of the ration as well as the crude fiber of the basal ration (clover hay) to better advantage during the period in which fish meal was fed than in the period in which no fish meal was given, a fact which has been observed before under conditions where high protein rations have been used.

In a report[3] (on *Fish Guano and Its Use as Food*) by Consul General Robert P. Skinner, Hamburg, Germany, it is stated that this material is used with great success in Germany as a supplementary stock food. Large quantities of it are exported to the United States, but it is all utilized for fertilizer purposes. In Norway codling and herring are the chief varieties of fish from which this material is made, while in England and Scotland the waste from all varieties of fish is used.

Herring meal, when made from fresh fish, has a protein content of from 60 to 70 per cent and a fat content of from 10 to 12 per cent, but when made from salt herring, the protein content is only about 50 per cent and the fat content 7 or 8 per cent.

The English fish meal is pressed while being kept hot with steam and has a fat content of only 3.6 per cent. Hogs are said to eat this fish meal eagerly, but it must be fed with care since an excessive quantity in the ration may affect the quality of the pork. Moderate quantities contribute to the animal's general health. The use of fish meal for feeding to swine is increasing in Germany from year to year.

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[1] Landw. Vers. Stat., 1910, 73 (1 & 3) 187–219.

[2] Landw. Vers. Stat., 1911, 75, 161–184.

[3] Daily Trade and Consular Report, 1911–14, No. 103, p. 512. See also American Fertilizer, May 6, 1911, p. 32 H.

In 1914 Klein[1] conducted feeding experiments on pigs older than those used in previous experiments but which were still growing, comparing skim milk with fat-free fish meal and dry fermentation residues. By substituting equivalent quantities of fish meal and of the dry residues for skim milk in the rations, the assimilation of these two food stuffs was observed as compared with skim milk. The results obtained show that fish meal and fermentation residues are well adapted as substitutes for skim milk. There was no marked difference in the character or flavor of the meat after slaughter.

E. Haselhoff,[2] in an article which includes the results of examination of 23 brands of fish meal found on the German market, points out that since this material has come to be quite extensively used in Germany as a feeding stuff its quality in many instances has greatly deteriorated. Fish meal prepared from strongly salted and from decomposed fish is condemned. One very reprehensible practice of adulteration has been the admixture of "cadaver" meal with the fish meal, to which serious outbreaks of disease (particularly anthrax) among stock have been traced. Such outbreaks result from the insufficient sterilization of the product prepared from animals dying of disease.

The composition of the different brands examined varied greatly. It was the opinion of the author that a fish meal deserving to be classed as a high-grade product should have a fat content of from 2 to 4 per cent, depending on the quantity to be used in the ration, and that the meal should not contain over 3 per cent of common salt. He recommends the following amounts of a high-grade meal in feeding rations:

Cattle, 2 pounds per 1,000 pounds, live weight.
Hogs, one-fourth to one-half pound per head, according to weight.
Sheep, one-fourth to one-half pound per 200 pounds, live weight.

The statement is made that the quality of the meat and lard is not injured by feeding hogs a little over one-half pound of fish meal per head per day.

In a special article[3] the Board of Agriculture and Fisheries of England called attention to the manufacture of fish meal and its value and use as a stock food. After the closing of the German market for this product, which consumed practically the entire amount (over 18,000 tons), the English farmer was urged to adopt its use.

In support of the use of fish meal for feeding purposes experiments are cited where a meal containing 3.5 per cent of fat and 55 per cent of protein material was fed to pigs for four months at the rate of 1 pound per head per day without any harmful effect on the flavor of the meat. In another feeding experiment cited, cows were fed very large amounts of a herring meal containing 20 per cent of oil without the flavor of the milk being affected. In a more recent feeding experiment quoted in this article the feeding of English fish meal to pigs in the proportion of from 15 to 30 per cent of the other foods given led to a marked increase in the weight of the pigs so fed compared with those fed on a ration containing no fish meal. The substitution of fish meal for a definite proportion of the various foods in the ration gave increased profits, amounting in one series to 42 per cent and in another to 94 per cent per pig, notwithstanding that the actual cost of feeding was higher.

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[1] Milchwirtsch. Zentr., 1914, *43*, 452, 458.

[2] Fühling's Landw. Zeit., Feb., 1914, *63* (4) 137.

[3] Jour. Board of Agric., Nov., 1914, *21*, 688.

The following quantities to be given daily, evidently taken in part from the German article quoted above, are suggested:

Cattle, 2 pounds per 1,000 pounds, live weight.
Pigs, ¼ to ½ pound, according to weight.
Sheep, 1/10 to 1/5 pound per 100 pounds, live weight.
Poultry (adult fowls) not more than 10 per cent, and chickens not more than 5 per cent of the entire ration.

In an extensive article[1] on the "Utilization of fish and marine animals as sources of oil and manure," attention is drawn to the use of fish meal as a cattle food. It is stated that this product has been used with success as a supplementary food for stock. According to this notice there are various grades of meal now on the English market, which are made from the waste of herring, cod, and other fish.

It is stated[2] that the horned dogfish, *Squalus acanthias*, is sometimes dried and used for feeding purposes in Scotland, Ireland, Norway, and elsewhere. It is stated also that cod meal may be made by simply drying and grinding the fish, but that in the case of herring it is necessary to remove most of the oil by the usual process of cooking, pressing, and drying. It is further stated that a good fish meal for feeding purposes should contain not less than 8.2 per cent of nitrogen and not over 5 per cent of oil.

In a study comparing the relative feeding value of fish and meat meals for fattening pigs, G. Martinoli[3] concluded that in fattening pigs from the earliest age fish meal proved of value in developing the skeleton and in stimulating the appetite and processes of assimilation. The animals fed on fish meal grew more rapidly than those fed on meat meal, and they were of superior quality. Neither the fish nor the meat meal imparted any particular smell or taste to the flesh of the animals.

In a bulletin from the Agricultural Experiment Station, Purdue University, A. G. Philips[4] gives the results of four experiments, each extending for one year, in which the value of meat scrap, fish scrap, and skim milk in rations for laying pullets was compared.

The summary of the results of this work shows that the pullets in the pens fed on a ration containing meat scrap averaged 135 eggs per pullet on a food consumption of 70.29 pounds per bird, at a cost of 98.4 cents per bird. For the fish-scrap pens the average number of eggs was 128 per pullet on a consumption of 74.13 pounds of food, at a cost of 99.5 cents per bird. The pullets in the pens fed on a ration including skim milk, produced an average of 135.4 eggs on 157.61 pounds of food consumed, costing $1.10 per bird.

It was determined that the amount of dry matter in the food required to produce one pound of eggs was 3.7 pounds in the meat-scrap pens, 4.02 pounds in the fish-scrap pens, 3.7 pounds in the skim-milk pens, and in the control pens, receiving none of the above materials, 13.53 pounds.

The average cost of producing one dozen eggs was 8.5 cents for the pullets fed on meat scrap, 9.7 cents for those fed on fish scrap, and 9.7 cents for those fed on skim milk. The profit per bird, over the cost of feed, was $1.55 for the pullets fed meat scrap, $1.56 for those fed fish scrap, and $1.62 for those fed skim milk.

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[1] Bulletin Imp. Ins., 1914, *12*, 429, 442.

[2] Bulletin Imp. Ins., July–Sept., 1914, *12*, No. 3.

[3] Rev. Centro. Estud. Agron. y Vet., 1914, 7, No. 72, pp. 258–270; abstracts in: Internat. Inst. Agr. (Rome); Mo. Bul. Agr. Intel. and Plant Diseases, 1915, 6, No. 3, pp. 445–446, and Exp. Sta. Record *33*, No. 6, p. 571.

[4] Agricultural Experiment Station, Purdue University, Bulletin 182, *18*, Nov., 1915. "Poultry Investigations: I, The value of meat scrap, fish scrap and skim milk in rations for laying pullets."

COMPOSITION AND QUALITIES OF FISH MEAL.

In the earlier experiments in this country, which have been reviewed, the material referred to is the undried cakes as they came from the presses. Since the advent of drying this residue has been converted into the fish scrap of the fish fertilizer industry. With proper attention, however, to sanitary considerations in the processes, it may be made into fish meal for feeding purposes.

The preparation of the material in this form makes it at once a commercial proposition, so far as shipping and ready use in compounding stock food rations are concerned. The meal containing less than 10 per cent of moisture will keep a very long time without decomposition or apparent chemical change. Portions of the experimental lots of fish meals made from sardine waste have been stored for over a year now, with apparently no change taking place. The product is usually shipped in 80 or 100 pound bags and will probably receive the same classification as fish fertilizer scrap, which at present is classified as 6th class in carload lots, or as 4th in less than carload lots (official classification); western classification: L. C. L., 3d; C. L., C.; southern classification: L. C. L., not taken; C. L., at fertilizer rates.

During the season of 1913–14 the Bureau of Chemistry made an extensive study of the sardine industry on the coast of Maine. It was during these investigations that attention was drawn to the large amount of waste in the packing of the fish as sardines, particularly at times when the fish were of large size. The possibility of utilizing this material as a stock food was considered and an investigation of the preparation and yield of material for this purpose was instituted during the season of 1914.

The question of the utilization of the fish waste on the Pacific coast has been extensively investigated by J. W. Turrentine[1] of the Bureau of Soils of this department as a part of the investigation of the fertilizer resources of the United States. The report of this work, which covers all phases of the subject, contains the analyses of five samples of dried "scrap" which were prepared at as many different factories from the waste in the canning of salmon. As the analysis indicates, they were well dried products, the water content ranging from 3.91 per cent to 5.36 per cent. The protein content ranged from 47.69 per cent to 59.31 per cent. It can be seen, therefore, that a product from this source has considerable value as a high-protein material, and it is said to be of very high quality.

Attention is also directed in this report to the use of the higher-grade "scrap" or meal as a stock and poultry food.

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[1] U. S. Department of Agriculture Bulletin No. 150.

The waste in the sardine industry affords excellent material for the preparation of a high-grade fish meal. As it comes from the packing table it has been steam cooked and partially dried in the process of preparing the fish for packing, and can be taken after collection from the packing tables directly to a plant equipped for pressing and drying. During the season of 1914 a quantity of fish meal was made in the course of experiments looking toward the utilization of this waste material as a stock food. A part of this waste is now utilized by converting it into "pomace" or "scrap" for use as a fertilizer. A number of experiments were made, using raw material varying in fat content and employing different methods of treatment preparatory to pressing and drying. The plant used for the experimental work was equipped with an iron cooker heated directly by steam, a rack and cloth screw press capable of yielding a pressure of 120 tons, and an ordinary type of rotary fertilizer drier. With this equipment a yield of from 27 to 33 per cent of meal was obtained from the fish residue; and from raw material containing from 12 to 17 per cent of oil, over one-half of the oil was removed by pressing. The oil obtained was bright, clear, and of very high quality. The fish meal from these excessively fat fish contained 17.51 per cent of oil. After pressing and drying raw material which contained from 8 to 9.5 per cent oil, a dried meal was obtained containing from 9 to 12 per cent of fat. The average composition of meal obtained in six different experiments was as follows:

	Per cent.
Water	7.71
Fat	15.19
Total nitrogen	9.39
Protein (Nx6.25)	58.70
Ash	15.18

This meal was stored in a barn at Eastport, Me., for a period of two or three months and was then shipped to Washington for use in feeding experiments after again being stored for about two months. The entire quantity, about 1 ton of meal comprising four of the experimental lots, was thoroughly mixed and was used for feeding experiments in cooperation with the Animal Husbandry and Dairy Divisions of the Bureau of Animal Industry of this department, using growing pigs, poultry, and dairy cows. The analysis of this meal and the composition of the fish are given on page 11.[1] It will be noted that there was a loss of 3 per cent of water during the time of storage and shipping.

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[1] The analysis of the meal was made by H. W. Houghton; of the ash by J. B. Wilson, both of the Animal Physiological Chemical Laboratory of the Bureau of Chemistry. The nitrogen determinations were all made by the Nitrogen Laboratory of the same bureau.

Analysis of Meal.

	Per cent.
Water	4.74
Ash	16.68
Total nitrogen	9.68
Protein (Nx6.25)	60.50
Fat	14.56
Crude fiber	0.61
Salt (NaCl)	5.78

Analysis of Ash.

Insoluble	0.50
Iron and aluminum (Fe_2O_3, Al_2O_3)	0.97
Phosphoric acid (P_2O_5)	35.32
Calcium (CaO)	26.86
Salt (NaCl)	25.83
Magnesium (MgO)	3.13

FEEDING EXPERIMENTS.[1]

DAIRY COWS.

The results obtained by the Dairy Division of the Bureau of Animal Industry by feeding the fish meal described above to dairy cows, were sufficiently satisfactory to warrant a more extended study of its value as a dairy feed. This work is to be undertaken during the coming winter. The preliminary experiments showed that the cows fed on a ration containing fish meal gave a greater yield of milk than cows fed on a similar basal ration containing no fish meal, but containing cottonseed meal. The milk from the cows which were fed fish meal contained a lower percentage of butter fat, but the total yield of fat obtained was approximately the same for the two groups. There was some variation in the readiness with which the animals ate the ration containing the fish meal. As a rule cows which have not been highly fed on feeds for which they have a fondness, will eat a fish-meal ration readily and are eager for it. In these tests the feeding of fish meal had no detrimental effect on either the milk or butter.

POULTRY.

The feeding experiments with poultry and with growing and fattening pigs were conducted by the Animal Husbandry Division of the Bureau of Animal Industry.

In the test with poultry a pen of laying hens fed a ration containing the fish meal was compared with a pen of the same breed fed a ration which was the same, except that in it meat meal was substituted for fish meal. The results of the experiment, which is designed to run for one year, are reported by Mr. Alfred R. Lee for a period of 32 weeks, as follows:

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[1] To Mr. George M. Rommel, Chief of the Animal Husbandry Division, and Mr. B. H. Rawl, Chief of the Dairy Division, of the Bureau of Animal Industry, acknowledgment is made for their cooperation and interest in the feeding experiments with the fish meal prepared from the waste in the packing of sardines.

> The mash fed consisted of one part each of bran, middlings, and fish meal and two parts of corn meal. In the check ration the fish meal was replaced by beef scrap. In addition, in each case a grain ration of equal parts of corn, wheat, and oats was fed. The beef scrap cost $53 per ton and was guaranteed to contain from 50 to 55 per cent of protein. The price for fish meal used in the calculation of the comparative costs was $46 per ton, a price recently quoted for a commercial article.
>
> The yield of eggs from the pen fed on the ration containing fish meal averaged 113.1 per hen, at a cost of 7.1 cents per dozen and with a food consumption of 44.1 pounds per hen. The average number of eggs per hen in the pen fed on the beef-scrap ration was 128.4, at a cost of 7.8 cents per dozen and with 55.7 pounds of food eaten. Estimating the value of the eggs at 30 cents per dozen, the profit from the pen fed on beef scrap would exceed that of the pen on fish meal by $2.48, or about 14 cents per hen, on account of the greater production in the former pen. At a price slightly under that quoted, fish meal would have been as profitable as beef scrap.
>
> At the present time the hens have eaten the beef scrap a little more freely and have given a slightly greater egg yield. No differences were noted in regard to size or flavor of the eggs or the health and weight of the fowls.

Similar results in regard to freedom from taint of fish in eggs were obtained by a manufacturer of poultry feeds who tested one of the experimental lots of meal prepared from the sardine waste. This particular lot of meal contained 17.51 per cent of fat and had no deleterious effect on the quality of the eggs.

PIGS.

A portion of the meal as used for feeding to cows and in compounding the ration fed to the poultry, was compared with tankage as a supplementary feeding stuff for growing and fattening pigs. This experiment was conducted by Mr. F. G. Ashbrook of the Animal Husbandry Division, Bureau of Animal Industry, who makes the following report of the work:

> The experiment was conducted to determine the comparative values of fish meal and tankage as supplements in a ration for growing and fattening pigs.
>
> The pigs used in this work were grade Berkshires, averaging 52.3 pounds per head when the experiment started. They were as uniform in size, age, and breeding as it was possible to obtain.
>
> For purposes of calculation the feeds used were estimated to cost as follows:
>
> Corn, 70 cents per bushel, plus $2 per ton for grinding, making $27 per ton.
> White middlings, $30 per ton.
> Digester tankage (60 per cent protein), $50 per ton.
> Fish meal, $35 per ton.
>
> It should not be assumed that this price is to establish arbitrarily a price for fish meal. As dried fish products have so largely been sold as fertilizers, it was thought that the price would to some extent be governed by the condition of the fertilizer market.

The guaranteed analysis of the tankage was:

	Per cent.
Protein	60
Fat	8
Phosphoric acid	8
Crude fiber	3

The feeding period was divided into two parts. First, a growing period of 112 days from weaning up to a fattening age, starting January 19, 1915, and ending May 11, 1915. Second, a fattening period of about one month, starting May 11, 1915, and ending June 8, 1915. The pigs at this date averaged a little better than 250 pounds and had to be sold.

Procedure.—The 12 pigs for the first period were divided into two lots. Lot No. 1, check lot, was composed of 8 pigs; lot No. 2 was composed of 4 pigs. During the first period, the pigs were fed as indicated below.

RESULTS DURING THE GROWING PERIOD.

The pigs, which were all in good, thrifty, growing condition, were about 3 months of age at the beginning of the experiment, and in order to accustom them to their surroundings they were fed in dry lot from the time they were weaned until the experiment was begun. The pigs in both lots were so fed that all the feed, which was in the form of a thin slop, was cleaned up at each feeding, thereby insuring a sharp appetite at the next feeding time. There was no trouble whatever in getting the pigs to eat the ration containing fish meal.

Growing period: Jan. 19, 1915, to May 11, 1915 (112 days).

Lot 1. Ration: 4 parts corn meal, 4 parts middlings, 1 part tankage:	
Duration of experiment ... days	112
Pigs ... number	8
Average first weight ... pounds	51. 37
Average final weight ... do	191. 50
Average gain per pig ... do	140. 13
Daily gain per pig ... do	1. 25
Total grain fed ... do	4, 060. 5
Average grain eaten per pig daily ... do	4. 53
Grain per 100 pounds gain ... do	362
Cost of 100 pounds gain ... dollars	5. 58
Lot 2. Ration: 4 parts corn meal, 4 parts middlings, 1 part fish meal:	
Duration of experiment ... days	112
Pigs ... number	4
Average first weight ... pounds	54. 25
Average final weight ... do	201. 50
Average gain per pig ... do	147. 25
Daily gain per pig ... do	1. 31
Total grain fed ... do	2, 152. 5
Average grain eaten per pig daily ... do	4. 80
Grain per 100 pounds gain ... do	365
Cost of 100 pounds gain ... dollars	5. 22

During the growing period the lot fed corn meal, middlings, and fish meal made a greater daily gain and a cheaper gain than the lot receiving the tankage supplement. The lot receiving the fish-meal supplement consumed 122.3 pounds more feed, gained a total of 28.5 pounds more, and cost 36 cents less per 100 pounds of gain, than did the lot to which tankage was fed. At the close of the growing period the average weight of the pigs fed fish meal was 201.5 pounds, while that for the pigs getting the tankage supplement was 191.5 pounds, a difference of 10 pounds. From observation there could be noted no difference between the two lots with respect to growth in the way of general development, which would indicate that one ration was not particularly superior to the other in meeting requirements for growth in pigs.

These same 12 pigs were used for the second period and were divided into lots and fed as follows:

Lot No. 3, composed of the same four pigs as lot No. 2 (in the growing period), was continued on the same ration, which consisted of: 4 parts of corn meal, 4 parts of middlings, 1 part of fish meal.

Lot No. 4, composed of four pigs from lot No. 1, was fed a ration of: 9 parts of corn meal, 1 part of fish meal.

Lot No. 5, composed of four pigs from lot No. 1, was fed a ration of: 9 parts of corn meal, 1 part of tankage.

RESULTS DURING THE FINISHING PERIOD.

At the close of the 16 weeks' growing period the hogs were divided into different lots in order to have them as uniform as possible for the finishing period. Lot 2 in the growing period was lot 3 in the fattening period. This lot was fed the same ration as in the growing period—4 parts corn meal, 4 parts middlings, 1 part fish meal. There are many farmers who feed the same ration both for the growing and fattening periods, and it was the intention to carry out such a scheme with this lot of hogs in order to determine the advisability of such a practice.

Fattening period: May 11, 1915, to June 8, 1915 (28 days).

Lot 3.—Ration: 4 parts corn meal, 4 parts middlings, 1 part fish meal:

Duration of experiment	days	28
Pigs	number	4
Average first weight	pounds	201.5
Average final weight	do	255.25
Average gain per pig	do	53.75
Daily gain per pig	do	1.91
Total grain fed	do	903
Average grain eaten per pig daily	do	8.06
Grain per 100 pounds gain	do	421
Cost of 100 pounds gain	dollars	6.04

Lot 4.—Ration: 9 parts corn meal, 1 part fish meal:

Duration of experiment	days	28
Pigs	number	4
Average first weight	pounds	191.5
Average final weight	do	251.75
Average gain per pig	do	60.25
Daily gain per pig	do	2.16
Total grain fed	do	956
Average grain eaten per pig daily	do	8.54
Grain per 100 pounds gain	do	393
Cost of 100 pounds gain	dollars	5.35

Lot 5.—Ration: 9 parts corn meal, 1 part tankage:

Duration of experiment	days	28
Pigs	number	4
Average first weight	pounds	192.0
Average final weight	do	248.00
Average gain per pig	do	54.00

Lot 5.—Ration: 9 parts corn meal, 1 part tankage—Continued.

Daily gain per pig	dollars..	2.00
Total grain fed	do....	910
Average grain eaten per pig daily	do....	8.13
Grain per 100 pounds gain	do....	462
Cost of 100 pounds gain	dollars..	6.76

The lot fed corn meal, middlings, and fish meal during the finishing period did not consume as much feed as the lot fed corn and fish meal or the lot fed corn meal and tankage. The cost of producing 100 pounds grain in the lot fed corn meal, middlings, and fish meal was 72 cents less than in the case of the lot fed corn meal and tankage; both lots, however, were about equal with respect to the average gain per pig during this period. The lot fed 9 parts of corn meal and 1 part of fish meal made a better showing than either of the other lots in the rate of gain, pounds of feed fed per 100 pounds gain, and the cost of 100 pounds gain.

CONCLUSIONS.

From this experiment the conclusion is justified that fish meal is a very effective supplement to a grain ration for pigs. Hogs relish it and are extremely fond of it, principally because, like tankage, it is a flesh product.

In this experiment fish meal was superior to tankage in all comparisons, although the average daily gains and rate of gains in all three lots used in the experiment were exceptionally good.

Where fish meal can be obtained conveniently at a reasonable price and in suitable quantity it has a very considerable value in hog feeding.

The results of these feeding tests, which were highly satisfactory in all respects, indicate the value of fish meal as a supplementary feed.

The pigs which were fed fish meal received it during the growing period at the rate of 0.5 pound per head per day, and during the fattening period they received this meal at the rate of 0.85 pound per head per day. They made greater gains and at a less cost than those fed a ration containing tankage as a supplement. The animals relished the fish meal and maintained a thrifty growth, and were never off their feed during the entire time of the test period.

The pen of hens was fed on fish meal in the proportion of 20 per cent of the weight of the mash. During the period of the experiment, which was not completed at the time this was reported, there was a slight advantage in the actual yield of eggs in favor of the meat meal. No taint or flavor of fish was at any time detected in the eggs from the hens fed on fish meal.

Dairy cows fed on a ration containing fish meal, compared with cows fed on a similar ration in which fish meal was replaced by cottonseed meal, gave a greater yield of milk, but it contained a lower percentage of butter fat. However, the total amount of fat obtained was approximately the same in both cases. There was no detrimental effect on either the milk or the butter from feeding the fish meal.

GENERAL METHODS FOR THE MANUFACTURE OF FISH MEAL.

Fish meal may be made by the same general methods that are now employed in the preparation of fish scrap for fertilizer purposes; that is, by steam cooking of the raw material, pressing, and drying. The chief difference, which should be constantly borne in mind, is that the meal is to be used as a stock food and should therefore be prepared from raw material in a perfectly fresh state and under clean, sanitary surroundings.

A steam-jacketed retort cooker, or one in which the material is heated directly by steam, may be employed. There is also an automatic continuous cooker which serves very well for cooking the raw material.

Pressing of the material may be accomplished by means of the hydraulic press, the rack and cloth type of press, or by the automatic continuous screw press. The material should be pressed while hot, thus insuring the removal of the maximum quantity of oil.

There are several types of dryers suitable for drying the material, among which are the rotary dryers using direct heat or steam heat, and the stationary steam-jacketed dryers provided with a rotating shaft and blades for stirring the material. In the latter type preference should be given to the dryer providing for evaporation under vacuum. In the former type, the final dried product is in a granular form, which is very desirable when it is to be used as a poultry food. For use in other stock-food mixtures it would be preferable to have it finely ground. The revolving blades in the latter type grind the material during the drying process to a fairly fine meal, and for all ordinary purposes it should not require further grinding. In some cases where large fish are used, further grinding may be necessary to remove the eye balls and large bones. No attempt is made to recommend any particular type or kind of cooker, press, or dryer. These should be selected according to individual requirements, depending on the character and the quantity of the waste to be converted into meal. The prospective manufacturer of fish meal should thoroughly study all the different forms of apparatus mentioned above and select the type best suited to his particular needs. The more modern and later methods of manufacture should also be investigated.

A prominent feature in connection with the preparation of fish and fishery wastes into material for feeding purposes is the production of a very superior grade of fish oil. The oil rendered from raw material which of necessity must be in a perfectly fresh state of preservation for making into meal for stock food, cannot be compared with fish oil obtained from material in any stage of decomposition. The former oil would require but little refining, for in the crude condition it has a bright, clear appearance, has very little fishy odor, and is free from rancidity. Its keeping qualities are excellent. Samples of large size obtained from the pressing of sardine waste have kept for over a year in as good condition, apparently, as when first prepared.

There is every reason for believing that the fish oil produced in the manufacture of fish meal is destined to become a valuable article, due to its far superior quality. At its present price the oil obtained at certain times of the season is sufficient to defray the cost of manufacture of the dried meal.

In the German market a fish meal containing a low percentage of oil (from 2 to 4 per cent) is considered the best grade of meal. On the Pacific coast the extraction of the oil by means of gasoline is being considered in the manufacture of fish meal in that locality. With a lower fat content a higher protein content is obtained, which is, of course, desirable. On the other hand, the fat, which is highly digestible, has a definite food value, and since it has been shown by experiment that high-grade fish meals of high fat content have been fed with no apparent taint being imparted to the final product, it is believed that the extraction of a fish meal to a fat content lower than that which could ordinarily be obtained by thorough and efficient pressing would be unnecessary. This is particularly apparent when it is considered that fish meal is to be used in relatively small quantities as a source of protein in balancing the rations of stock and in preparing the finished commercial stock feeds.

Further, it is believed that any trouble that may have been attributed to a high fat content in the meal probably was due to rank, rancid oil, developed in decomposing raw material. Such oil is not present in meal prepared from fresh, undecomposed fish and fish wastes. Certainly a fat content of 14.56 per cent in a meal of this character, as in that made from the waste in the packing of sardines, would appear to be satisfactory, since no flavor or taint of fish was imparted to eggs, milk, or butter in the experiments which were conducted with it.

Care on the part of the producer and purchaser should be exercised to make sure that the meal is of good quality, such as can only be obtained by preparation from wholesome, undecomposed raw material. A fish meal should not be manufactured from the waste and residues of salt fish. The excessive quantity of salt in such a meal may, when it is used for feeding purposes, result in harmful effects; and as a large amount of the protein compounds have been extracted by the salt, the resulting meal would be low in food value. With care and attention to sanitary features in its production, fish meal can be made one of the best and cleanest of feeding materials.

Conditions which obtain in plants where fish scrap for fertilizer is made, and the use of decomposed and putrid raw material, must not be permitted in the preparation of fish meal for feeding purposes. It is believed that fish meal, properly prepared, can be developed into one of the greatest sources of supply of high-protein stock feeds, and great care should be exercised not to ruin the possibilities at the very beginning of the enterprise by preparing and marketing an article unfit for feeding purposes.

It is suggested that the trade names, fish "scrap," fish "pomace," or fish "guano," be retained and be specifically applied to the product which is to be used as a fertilizer and which has been prepared with no great care in regard to factory cleanliness or to the degree of spoilage of the raw material, and that the name "fish meal" be applied to the product specifically prepared for feeding purposes.

OPINIONS OF THE TRADE IN REGARD TO FEEDING FISH MEAL.

The question of the use of fish meal by the trade was touched upon by correspondence with a number of the leading stock-food manufacturers at the time the experimental lots of meal were being prepared at Eastport, Me., during the sardine season of 1914. Samples of the meal and the analyses were submitted and the manufacturers were asked to express their opinion of it, and to state whether they had had any experience with the use of fish meal and whether they could use it in the preparation of a stock or poultry food.

Only two of the manufacturers had ever used fish meal and this was in compounding poultry mashes. One firm which used it for this purpose stated they would be able to handle the entire output from the sardine industry. Several of the firms stated that in their opinion it would be valuable material for poultry feeds, while others were quite willing to try it for the manufacture of hog feed, stating that it should be able to replace tankage to good advantage, particularly if a more favorable price could be obtained.

Some doubted whether it could be used for a dairy feed on account of the fishy odor which might prevent the animals from eating it and because of the possibility of tainting the products. If it could be used for this purpose, it was the opinion of some that it would be a very valuable substance in preparing dairy feeds and a great boon to the dairy industry.

While only two of the firms had ever had any experience with the use of this material for feeding, they were all very much interested and made inquiries as to the amount of the material available, shipping classifications, and price. From this interest displayed and the favorable results obtained by its use, it would seem that a market should be assured for a good, well-prepared article.

RAW MATERIAL AVAILABLE FOR FISH MEAL.

There is already at hand a large amount of dried-fish product called fish "scrap" or "pomace" now used for fertilizer purposes, the marketing channel of which—or part of it, at least—could be turned in the direction of the stock-food manufacturing industry instead of into the fertilizer industry. This, however, can not be done until the product is prepared under conditions which would insure its safe use for feeding purposes. As previously pointed out, the value of this material as a fertilizer is not reduced by feeding it.

The menhaden fish "scrap" industry and the salmon, sardine, and tuna canning industries offer at the present time a large source of supply of fish meal, approximating 120,000 tons annually.

In 1912, 50,885 tons of dry fish fertilizer "scrap" and 37,536 tons of acidulated[1] "scrap" were produced in the menhaden fish-scrap industry.[2] The amount that could be obtained from the waste in the sardine industry will vary somewhat in different seasons. Assuming that the entire waste material would be converted into fish meal, it is estimated that from 2,000 to 4,000 tons per season could be prepared.

Thirty-five thousand to forty thousand tons per year of dry meal could be obtained from the utilization of the waste of the Pacific coast salmon canneries.[3]

Since the amount of waste in the salmon-canning industry that could be made into fish meal for feeding purposes is, at the present time, so far in excess of that of any other available supply, fish meal from this industry should soon become of importance in supplying the large western and middle-western area with this material. As before mentioned, fish meal for stock-feeding purposes is now prepared in limited quantities from the salmon-cannery waste.

No figures are at hand for estimating the amount which could be obtained from the tuna-canning industry or from the individual canneries of various fish products scattered throughout the country.

In addition to the amount that may be obtained from these sources a considerable quantity may be obtained from other fish not considered sufficiently good for food purposes, particularly the dogfish. This fish, the destruction of which is so much desired by all classes of fishermen, could well be handled at small by-product plants attached to canneries, at the time of the preparation of meal from the waste, or in larger factories devoted entirely to the manufacture of meal. It would seem that in this new field for the use of fish meal for feeding purposes an outlet may have been found for the use of this outcast of the fish tribe and that it can at last be turned into material having a commercial and economic value.

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[1] This acidulated fish "scrap" is prepared by adding sulphuric acid to the fresh stock. It seems hardly necessary to state that a meal prepared from material so treated should never be used for feeding animals. The prospective user should insist on a guaranty that sulphuric acid was not used in the preparation of meal or should have its absence established before using the meal for feeding purposes.

[2] Greer, "The Menhaden Industry of the Atlantic Coast," Bureau of Fisheries Document No. 811, p. 21.

[3] Turrentine (U. S. Dept. Agr. Bull. 150, "Utilization of the fish waste of the Pacific Coast for the manufacture of fertilzer") estimates the total waste as 140,210 tons of raw material. By calculating on the basis of a 25 or 30 per cent yield of dry meal, the above figures were obtained.

The addition of this fish in liberal quantities to waste material from canneries, comprising heads, tails, fins, and only a small proportion of the meat portion of the fish, would greatly increase the feeding value of the resulting meal.

Attention should be called to the difference in composition—particularly of the protein material—of fish meal made from whole fish or from waste containing a large portion of the edible part of the fish, and of a fish meal prepared from waste composed entirely of the heads, tails, and fins. In the latter case gelatin or glue derived from the collogen of the cartilage, bones, and fins, will predominate as the protein constituent, and a meal thus prepared will not have so high a feeding value as one in which the protein derived from the meat or flesh of the fish predominates.

In instances where waste deficient in the protein constituents of whole fish is available, the dogfish will serve to good advantage as a means of supplying this deficiency and will increase the content of essential tissue-building material.

GENERAL CONCLUSIONS.

The universally favorable results obtained in the feeding of fish meal appear to warrant its extended use as a supplementary feeding stuff.

Laboratory tests have shown that the coefficients of digestibility of the principal constituents of fish meal—the protein and fat—are high, and the feeding experiments have all shown it to be as valuable as many other high-protein concentrates with which it has been compared.

From the feeding experiments it appears that there has not been just cause for the assumption that the feeding of fish meal of good quality imparts a fishy taint to such products as milk, butter, eggs, and meat. When the meal is fed in proper quantities, as a supplementary feed with other feeds, apparently no deleterious effects are noticeable in regard to taint or flavor of fish. There is a possibility that it may impart its flavor to the products of animals or fowls when it is fed to them in too large quantities. Even under these circumstances its use would be warranted, as the feeding of the meal can be discontinued a sufficient length of time during the final fattening period to eliminate any objectionable taint.

An enormous field is opened up to the various fishing industries for the preparation of a valuable material either from waste residues or from whole fish and for the utilization of this material to better advantage than heretofore. Likewise for the farmer, stock raiser, and poultry man, a hitherto neglected source of supply of a high-protein feeding stuff is available.

In the light of the recorded experiments on the use of this material for feeding purposes and the feeding tests with the herring meal prepared from the sardine waste, conducted in this department, it is believed that all doubts as to the feasibility of using fish meal as a feeding stuff may be dispelled, and it is confidently expected that in time it will take its place as one of the leading protein concentrates used as a supplementary stock food.

As a final conclusion in regard to the subject of fish meal as a stock food it can be said to those who may be interested in producing this material that there is a great need and a splendid opportunity in the market for it.

To those who may be interested in using the product it can be said that fish meal is as valuable as other widely used high-protein feeding stuffs, and in some instances has been proved more valuable than these; that it does not impart its flavor to animal products if fed in reasonable amounts in conjunction with other foods; and, finally, that it should be given consideration whenever a high-protein foodstuff is required.

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